

CLAIMS LISTING

1. (currently amended) A method for optimizing a wireless electromagnetic communications network, comprising:

a wireless electromagnetic communications network, comprising

a set of nodes, said set of nodes further comprising,

at least a first subset wherein each node is MIMO-capable, comprising:

an antennae array of M M antennae, where $M \geq$ one,

a transceiver for each antenna in said spatially diverse antennae array,

means for digital signal processing to convert analog radio signals into digital signals and digital signals into analog radio signals,

means for coding and decoding data, symbols, and control information into and from digital signals.

diversity capability means for transmission and reception of said analog radio waves-signals,

and,

mean

means for input and output from and to a non-radio interface for digital signals;

said set of nodes being deployed according to design rules that prefer meeting the following criteria:

said set of nodes further comprising two or more proper subsets of nodes, with a first proper subset being the transmit uplink / receive downlink set, and a second proper subset being the transmit downlink / receive uplink set;

each node in said set of nodes belonging to no more transmitting uplink or receiving uplink subsets than it has diversity capability means;

31 each node in a transmit uplink / receive downlink subset has no
32 more nodes with which it will hold time and frequency coincident
33 communications in its field of view, than it has diversity capability
34 means;
35 each node in a transmit downlink / receive uplink subset has no
36 more nodes with which it will hold time and frequency coincident
37 communications in its field of view, than it has diversity capability
38 means;
39 each member of a transmit uplink / receive downlink subset cannot
40 hold time and frequency coincident communications with any
41 other member of that transmit uplink / receive downlink subset;
42 and,
43 each member of a transmit downlink / receive uplink subset cannot
44 hold time and frequency coincident communications with any
45 other member of that transmit downlink / receive uplink subset;
46 transmitting, in said wireless electromagnetic communications network,
47 independent information from each node belonging to a first proper subset, to one
48 or more receiving nodes belonging to a second proper subset that are viewable
49 from the transmitting node;
50 processing independently, in said wireless electromagnetic communications
51 network, at each receiving node belonging to said second proper subset,
52 information transmitted from one or more nodes belonging to said first proper
53 subset;
54 and,
55 dynamically adapting the diversity ~~channels~~ capability means and said proper
56 subsets to optimize said network.

57
58
59 2. (currently amended) A method for optimizing a wireless electromagnetic
60 communications network, comprising:
61 a wireless electromagnetic communications network, comprising

62 a set of nodes, said set of nodes further comprising,
63 at least a first subset wherein each node is MIMO-capable,
64 comprising:
65 a spatially diverse antennae array of M M antennae, where
66 M \geq two,
67 a transceiver for each antenna in said spatially diverse
68 antennae array,
69 means for digital signal processing to convert analog radio
70 signals into digital signals and digital signals into analog
71 radio signals,
72 means for coding and decoding data, symbols, and control
73 information into and from digital signals,
74 diversity capability means for transmission and reception of
75 said analog radio ~~waves~~ signals,
76 and,
77 means for input and output from and to a non-radio
78 interface for digital signals;
79 said set of nodes being deployed according to design rules that prefer
80 meeting the following criteria:
81 said set of nodes further comprising two or more proper subsets of
82 nodes, with a first proper subset being the transmit uplink / receive
83 downlink set, and a second proper subset being the transmit
84 downlink / receive uplink set;
85 each node in said set of nodes belonging to no more transmitting
86 uplink or receiving uplink subsets than it has diversity capability
87 means;
88 each node in a transmit uplink / receive downlink subset has no
89 more nodes with which it will hold time and frequency coincident
90 communications in its field of view, than it has diversity capability
91 means;

92 each node in a transmit downlink / receive uplink subset has no
93 more nodes with which it will hold time and frequency coincident
94 communications in its field of view, than it has diversity capability
95 means;

96 each member of a transmit uplink / receive downlink subset cannot
97 hold time and frequency coincident communications with any
98 other member of that transmit uplink / receive downlink subset;

99 and,

100 each member of a transmit downlink / receive uplink subset cannot
101 hold time and frequency coincident communications with any
102 other member of that transmit downlink / receive uplink subset;

103 transmitting, in said wireless electromagnetic communications network,
104 independent information from each node belonging to a first proper subset, to one
105 or more receiving nodes belonging to a second proper subset that are viewable
106 from the transmitting node;

107 processing independently, in said wireless electromagnetic communications
108 network, at each receiving node belonging to said second proper subset,
109 information transmitted from one or more nodes belonging to said first proper
110 subset;

111 and,

112 dynamically adapting the diversity channels capability means and said proper
113 subsets to optimize said network.

114

115

116 3. (currently amended) A method as in claim 1, wherein dynamically adapting the
117 diversity channels capability means and said proper subsets to optimize said network
118 further comprises:

119 using substantive null steering to minimize SINR between nodes transmitting and
120 receiving information.

121

122

- 123 4. (currently amended) A method as in claim 1, wherein dynamically adapting the
124 diversity ~~channels~~ capability means and said proper subsets to optimize said network
125 further comprises:
126 using max-SINR null- and beam-steering to minimize intra-network interference.
127
128
- 129 5. (currently amended) A method as in claim 1, wherein dynamically adapting the
130 diversity ~~channels~~ capability means and said proper subsets to optimize said network
131 further comprises:
132 using MMSE null- and beam-steering to minimize intra-network interference.
133
134
- 135 6. (currently amended) A method as in claim 1, wherein dynamically adapting the
136 diversity ~~channels~~ capability means and said proper subsets to optimize said network
137 further comprises:
138
139 designing the network such that reciprocal symmetry exists for each pairing of
140 uplink receive and downlink receive proper subsets.
141
- 142 7. (currently amended) A method as in claim 1, wherein dynamically adapting the
143 diversity ~~channels~~ capability means and said proper subsets to optimize said network
144 further comprises:
145
146 designing the network such that substantial reciprocal symmetry exists for each
147 pairing of uplink receive and downlink receive proper subsets.
148
- 149 8. (original) A method as in claim 1, wherein the network uses TDD communication
150 protocols.
151
- 152 9. (original) A method as in claim 1, wherein the network uses FDD communication
153 protocols.

154

155 10. (original) A method as in claim 3, wherein the network uses simplex communication
156 protocols.

157

158 11. (original) A method as in claim 1, wherein the network uses random access packets,
159 and receive and transmit operations are all carried out on the same frequency channels for
160 each link.

161

162 12. (currently amended) A method as in claim 1, wherein dynamically adapting the
163 diversity channels capability means and said proper subsets to optimize said network
164 further comprises

165

if the received interference is spatially white in both link directions, setting

167 ~~$g_1(aq) \rightleftharpoons w^* \rightleftharpoons g_2(q)$ and $g_2(q) \rightleftharpoons w^* \rightleftharpoons g_1(aq)$~~

168 $\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)$ at both ends of the link,

169 where $\{g_2(q), w_1(q)\}$

170 $\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$ are the linear transmit and receive weights used in the
171 downlink;

173

but if the received interference is not spatially white in both link directions,

174 constraining $\{g_1(q)\}$ and $\{g_2(q)\}$ $\{g_1(q)\}$ and $\{g_2(q)\}$ to
 175 preferentially satisfy:

176

177 Q₂₊ ————— N₄₊

$$178 \quad \sum_{q} g^T_+(q) R_{i+i+}[n_+(q)] g^*_+(q) = \sum_{n=1} \text{Tr}\{R_{i+i+}(n)\} = M_i R_i$$

179 e=1 n=1

180

181 Q_{12} _____ N_2

182 $\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q) \mathbf{R}_{i_2 i_2}[n_2(q)] \mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{i_2 i_2}(n)\} = M_2 R_2$

183 $q = 1$ _____ $n = 1$

184

185 $\sum_{q=1}^{Q_{12}} \mathbf{g}_1^T(q) \mathbf{R}_{i_1 i_1}(n_1(q)) \mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \text{Tr}\{\mathbf{R}_{i_1 i_1}(n)\} = M_1 R_1$

186

187 $\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q) \mathbf{R}_{i_2 i_2}(n_2(q)) \mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{i_2 i_2}(n)\} = M_2 R_2$

188

189

190 13. (currently amended) A method as in claim 1, wherein:

191 a proper subset may incorporate one or more nodes that are in a receive-only
192 mode for every diversity channel capability means.

193

194

195 14. (original) A method as in claim 1, wherein:

196 the network may dynamically reassign a node from one proper subset to another.

197

198

199 15. (original) A method as in claim 1, wherein:

200 the network may dynamically reassign a proper subset of nodes from one proper
201 subset to another.

202

203

204 16. (currently amended) A method as in claim 7, wherein the step of designing the
205 network such that substantial reciprocal symmetry exists for the uplink and downlink
206 channels further comprises:

207

208 if the received interference is spatially white in both link directions, setting

209

210 $\underline{\mathbf{g}_1(q) \propto \mathbf{w}_2^*(q)}$ and $\underline{\mathbf{g}_2(q) \propto \mathbf{w}_1^*(q)}$

211 $\underline{\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)}$ and $\underline{\mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)}$ at both ends of the link, where

212 $\underline{\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}}$ $\underline{\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}}$ are the linear transmit and
213 receive weights used in the downlink;

214

215 but if the received interference is not spatially white in both link directions,

216 constraining $\underline{\{\mathbf{g}_1(q)\}}$ and $\underline{\{\mathbf{g}_2(q)\}}$ $\underline{\{\mathbf{g}_1(q)\}}$ and $\underline{\{\mathbf{g}_2(q)\}}$ to
217 preferentially satisfy:

218

219 $\underline{Q_{21}} \quad \underline{N_1}$

220 $\sum_{q=1}^{Q_{21}} \underline{\mathbf{g}_1^T(q) \mathbf{R}_{i1i1} [\mathbf{n}_1(q)] \mathbf{g}_1^*(q)} = \sum_{n=1}^{N_1} \underline{\text{Tr}\{\mathbf{R}_{i1i1}(n)\}} = \underline{\mathbf{M}_1 \mathbf{R}_1}$

221 $\underline{q=1} \quad \underline{n=1}$

222

223 $\underline{Q_{12}} \quad \underline{N_2}$

224 $\sum_{q=1}^{Q_{12}} \underline{\mathbf{g}_2^T(q) \mathbf{R}_{i2i2} [\mathbf{n}_2(q)] \mathbf{g}_2^*(q)} = \sum_{n=1}^{N_2} \underline{\text{Tr}\{\mathbf{R}_{i2i2}(n)\}} =$

225 $\underline{\mathbf{M}_2 \mathbf{R}_2}$

226 $\underline{q=1} \quad \underline{n=1}$

227

228

229 $\sum_{q=1}^{Q_{21}} \underline{\mathbf{g}_1^T(q) \mathbf{R}_{i1i1}(n_1(q)) \mathbf{g}_1^*(q)} = \sum_{n=1}^{N_1} \underline{\text{Tr}\{\mathbf{R}_{i1i1}(n)\}} = M_1 R_1$

230
$$\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q) \mathbf{R}_{\mathbf{i}_2 \mathbf{i}_2}(n_2(q)) \mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{\mathbf{i}_2 \mathbf{i}_2}(n)\} = M_2 R_2$$

231

232

233 17. (original) A method as in claim 1, wherein the means for digital signal processing in
234 said first subset of MIMO-capable nodes further comprises:

235

236 an ADC bank for downconversion of received RF signals into digital signals;

237 a MT DEMOD element for multitone demodulation, separating the received

238 signal into distinct tones and splitting them into 1 through K K feed FDMA

239 channels, said separated tones in aggregate forming the entire baseband for the
240 transmission, said MT DEMOD element further comprising

241 a Comb element with a multiple of 2 filter capable of operating on a 128-
242 bit sample; and,

243 an FFT element with a 1,024 real-IF function;

244 a Mapping element for mapping the demodulated multitone signals into a 426
245 active receive bins, wherein

246 each bin covers a bandwidth of 5.75MHz;

247 each bin has an inner passband of 4.26MHz for a content envelope;

248 each bin has an external buffer, up and down, of 745kHz;

249 each bin has 13 channels, CH0 through CH12, each channel having 320
250 kHz and 32 tones, T0 through T31, each tone being 10kHz, with the inner
251 30 tones being used information bearing and T0 and T31 being reserved;
252 each signal being 100μs, with 12.5μs at each end thereof at the front and
253 rear end thereof forming respectively a cyclic prefix and cyclic suffix
254 buffer to punctuate successive signals;

255 and,

256 a symbol-decoding element for interpretation of the symbols embedded in the
257 signal.

258

259
260
261 18. (currently amended) A method as in claim 1, wherein dynamically adapting the
262 diversity channels capability means and said proper subsets to optimize said network
263 further comprises
264
265 using at each node the receive combiner weights as transmit distribution weights
266 during subsequent transmission operations, so that the network is preferentially
267 designed and constrained such that each link is substantially reciprocal, such that
268 the ad hoc network capacity measure can be made equal in both link directions by
269 setting at both ends of the link:
270
271 ~~$\mathbf{g}_2(q) \propto \mathbf{w}_2^*(k,q)$ and $\mathbf{g}_1(k,q) \propto \mathbf{w}_1^*(k,q)$~~
272 $\mathbf{g}_2(k,q) \propto \mathbf{w}_2^*(k,q)$ and $\mathbf{g}_1(k,q) \propto \mathbf{w}_1^*(k,q)$,
273
274 where ~~$\{\mathbf{g}_2(k,q), \mathbf{w}_1(k,q)\}$~~ $\{\mathbf{g}_2(k,q), \mathbf{w}_1(k,q)\}$ are the
275 linear transmit and receive weights to transmit data $d_2(k,q)$ from node
276 $n_2(q)$ to node $n_1(q)$ over channel k in the downlink, and where
277 $\{\mathbf{g}_1(k,q), \mathbf{w}_2(k,q)\}$ are the linear transmit and receive weights used
278 to transmit data $d_1(k,q)$ from node $n_1(q)$ back to node $n_2(q)$ over
279 equivalent channel k in the uplink.
280
281
282
283 19. (currently amended) A method as in claim 1, wherein the step of each node in a
284 transmit downlink / receive uplink subset having no more nodes with which it will hold

285 time and frequency coincident communications in its field of view, than it has diversity
286 capability means further comprises:

287

288 designing the topological, physical layout of nodes to enforce this constraint
289 within the node's diversity channels capability means limitations.

290

291

292 20. (currently amended) A method as in claim 1, wherein the step of each node in a
293 transmit uplink / receive downlink subset having no more nodes with which it will hold
294 time and frequency coincident communications in its field of view, than it has diversity
295 capability means further comprises:

296 designing the topological, physical layout of nodes to enforce this constraint
297 within the node's diversity channels capability means limitations.

298

299

300 21. (currently amended) A method as in claim 1, wherein the step of dynamically
301 adapting the diversity channels capability means and said proper subsets to optimize said
302 network further comprises:

303 allowing a proper subset to send redundant data transmissions over multiple
304 frequency channels to another proper subset.

305

306

307 22. (original) A method as in claim 1, wherein the step of dynamically adapting the
308 diversity channels capability means and said proper subsets to optimize said network
309 further comprises:

310 allowing a proper subset to send redundant data transmissions over multiple
311 simultaneous or differential time slots to another proper subset.

312

313

314 23. (original) A method as in claim 1, wherein said transmitting proper subset and
315 receiving proper subset diversity capability means for transmission and reception of said
316 analog radio ~~waves~~ signals further comprise:

317 spatial diversity of antennae.

318

319

320 24. (original) A method as in claim 1, wherein said transmitting proper subset and
321 receiving proper subset diversity capability means for transmission and reception of said
322 analog radio ~~waves~~ signals further comprise:

323 polarization diversity of antennae.

324

325

326 25. (original) A method as in claim 1, wherein said transmitting proper subset and
327 receiving proper subset diversity capability means for transmission and reception of said
328 analog radio ~~waves~~ signals further comprise:

329 any combination of temporal, spatial, and polarization diversity of antennae.

330

331

332 26. (currently amended) A method as in claim 1, wherein the step of dynamically
333 adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said
334 network further comprises:

335 incorporating network control and feedback aspects as part of the signal encoding
336 process.

337

338

339 27. (currently amended) A method as in claim 1, wherein the step of dynamically
340 adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said
341 network further comprises:

342 incorporating network control and feedback aspects as part of the signal encoding
343 process and including said as network information in one direction of the
344 signalling and optimization process, using the perceived environmental

345 condition's effect upon the signals in the other direction of the signalling and
346 optimization process.

347

348

349 28. (currently amended) A method as in claim 1, wherein the step of dynamically
350 adapting the diversity channels capability means and said proper subsets to optimize said
351 network further comprises:

352 adjusting the diversity channel capability means use between any proper sets of
353 nodes by rerouting any active link based on perceived unacceptable SINR
354 experienced on that active link and the existence of an alternative available link
355 using said adjusted diversity channel capability means.

356

357

358 29. (currently amended) A method as in claim 1, wherein the step of dynamically
359 adapting the diversity channels capability means and said proper subsets to optimize said
360 network further comprises:

361 switching a particular node from one proper subset to another due to changes in
362 the external environment affecting links between that node and other nodes in the
363 network.

364

365

366 30. (currently amended) A method as in claim 1, wherein the step of dynamically
367 adapting the diversity channels capability means and said proper subsets to optimize said
368 network further comprises:

369 dynamically reshuffling proper subsets to more closely attain network objectives
370 by taking advantage of diversity channels capability means availability.

371

372

373 31. (currently amended) A method as in claim 1, wherein the step of dynamically
374 adapting the diversity channels capability means and said proper subsets to optimize said
375 network further comprises:

376 dynamically reshuffling proper subsets to more closely attain network objectives
377 by accounting for node changes.

378

379

380 32. (currently amended) A method as in claim 31, wherein said node changes
381 include any of:

382 adding diversity capability means to a node, adding a new node within the field of
383 view of another node, removing a node from the network (temporarily or
384 permanently), or losing diversity capability means at a node.

385

386

387 33. (currently amended) A method as in claim 1, wherein the step of dynamically
388 adapting the diversity channels capability means and said proper subsets to optimize said
389 network further comprises:

390 suppressing unintended recipients or transmitters by the imposition of signal
391 masking.

392

393

394 34. (original) A method as in claim 33, wherein the step of suppressing unintended
395 recipients or transmitters by the imposition of signal masking further comprises:
396 imposition of an origination mask.

397

398

399 34. (original) A method as in claim 33, wherein the step of suppressing unintended
400 recipients or transmitters by the imposition of signal masking further comprises:
401 imposition of a recipient mask.

402

403

404 35. (original) A method as in claim 33, wherein the step of suppressing unintended
405 recipients or transmitters by the imposition of signal masking further comprises:
406 imposition of any combination of origination and recipient masks.

407

408

409 36. (currently amended) A method as in claim 33, wherein the step of dynamically
410 adapting the diversity channels capability means and said proper subsets to optimize said
411 network further comprises:

412 using signal masking to secure transmissions against unintentional, interim
413 interception and decryption by the imposition of a signal mask at origination, the
414 transmission through any number of intermediate nodes lacking said signal mask,
415 and the reception at the desired recipient which possesses the correct means for
416 removal of the signal mask.

417

418

419 37. (original) A method as in claim 36, wherein the signal masking is shared by a proper
420 subset.

421

422

423 38. (currently amended) A method as in claim 1, wherein the step of dynamically
424 adapting the diversity channels capability means and said proper subsets to optimize said
425 network further comprises:

426 heterogenous combination of a hierarchy of proper subsets, one within the other,
427 each paired with a separable subset wherein the first is a transmit uplink and the
428 second is a transmit downlink subset, such that the first subset of each pair of
429 subsets is capable of communication with the members of the second subset of
430 each pair, yet neither subset may communicate between its own members.

431

432

433 39. (original) A method as in claim 1, wherein the step of dynamically adapting the
434 diversity channels capability means and said proper subsets to optimize said network
435 further comprises:

436 using as many of the available diversity channels capability means as are needed
437 for traffic between any two nodes from 1 to NumChannels, where NumChannels
438 equals the maximal diversity capability means between said two nodes.

439

440 40. (original) A method as in claim 1, wherein the step of dynamically adapting the
441 diversity channels capability means and said proper subsets to optimize said network
442 further comprises:

443 using using a water-filling algorithm to route traffic between an origination and
444 destination node through any intermediate subset of nodes that has available
445 diversity channel capability means capacity.

446

447

448 41. (currently amended) A method for optimizing a wireless electromagnetic
449 communications network, comprising:

450 a wireless electromagnetic communications network, comprising

451 a set of nodes, said set further comprising,

452 at least a first subset of MIMO-capable nodes, each MIMO-
453 capable node comprising:

454 a spatially diverse antennae array of M M antennae, where
455 M-M ≥ two, said antennae array being polarization diverse,
456 and circularly symmetric, and providing 1-to-M RF feeds;
457 a transceiver for each antenna in said array, said transceiver
458 further comprising

459 a Butler Mode Forming element, providing spatial
460 signature separation with a FFT-LS algorithm,
461 reciprocally forming a transmission with shared
462 receiver feeds, such that the number of modes out
463 equals the numbers of antennae, establishing such
464 as an ordered set with decreasing energy, further
465 comprising:

466 a dual-polarization element for splitting the
467 modes into positive and negative polarities
468 with opposite and orthogonal polarizations,
469 that can work with circular polarizations,
470 and
471 a dual-polarized link CODEC;
472 a transmission/reception switch comprising,
473 a vector OFDM receiver element;
474 a vector OFDM transmitter element;
475 a LNA bank for a receive signal, said LNA
476 Bank also instantiating low noise
477 characteristics for a transmit signal;
478 a PA bank for the transmit signal that
479 receives the low noise characteristics for
480 said transmit signal from said LNA bank;
481 an AGC for said LNA bank and PA bank;
482 a controller element for said
483 transmission/reception switch enabling
484 baseband link distribution of the energy over
485 the multiple RF feeds on each channel to
486 steer up to K K_{feed} beams and nulls
487 independently on each FDMA channel;
488 a Frequency Translator;
489 a timing synchronization element controlling
490 said controller element;
491 further comprising a system clock,
492 a universal Time signal element;
493 GPS;
494 a multimode power management element
495 and algorithm;
496 and,

information bearing and T0 and T31 being reserved; each signal being ~~100~~100 μ s, with ~~12.5~~12.5 μ s at each end thereof at the front and rear end thereof forming respectively a cyclic prefix and cyclic suffix buffer to punctuate successive signals;

a MUX element for timing modification capable of element-wise multiplication across the signal, which halves the number of bins and tones but repeats the signal for high-quality needs;

a link CODEC, which separates each FDMA channel into 1 through ~~M~~M links, further comprising

- 544 a SOVA bit recovery element;
- 545 an error coding element;
- 546 an error detection element;
- 547 an ITI remove element;
- 548 a tone equalization element;
- 549 and,
- 550 a package fragment retransmission element;
- 551

552 a multilink diversity combining element, using a multilink Rx weight adaptation

553 algorithm for Rx signal weights $\underline{\mathbf{W}(k)}$

554

555 $\underline{\mathbf{W}(k)}$ to adapt transmission gains

556 $\mathbf{G}(k)$ $\mathbf{G}(k)$ for each channel k k ;

557 an equalization algorithm, taking the signal
558 from said multilink diversity combining
559 element and controlling a delay removal
560 element;
561 said delay removal element separating signal
562 content from imposed pseudodelay and
563 experienced environmental signal delay, and
564 passing the content-bearing signal to a
565 symbol-decoding element;
566 said symbol-decoding element for
567 interpretation of the symbols embedded in
568 the signal, further comprising:
569 an element for delay gating;
570 a QAM element; and
571 a PSK element;
572 said vector OFDM transmitter element comprising:
573 a DAC bank for conversion of digital signals
574 into RF signals for transmission;
575 a MT MOD element for multitone
576 modulation, combining and joining the
577 signal to be transmitted from 1 through K
578 K_{feed} FDMA channels, said separated tones
579 in aggregate forming the entire baseband for
580 the transmission, said MT MOD element
581 further comprising
582 a Comb element with a multiple of 2
583 filter capable of operating on a 128-
584 bit sample; and,
585 an IFFT element with a 1,024 real-IF
586 function;

587 a Mapping element for mapping the
588 modulated multitone signals from 426
589 active transmit bins, wherein
590 each bin covers a bandwidth of
591 ~~5.75MHz~~ 5.75 MHz;
592 each bin has an inner passband of
593 ~~4.26MHz~~ 4.26 MHz for a content
594 envelope;
595 each bin has an external buffer, up
596 and down, of ~~745kHz~~ 745 kHz;
597 each bin has 13 channels, CH0
598 through CH12, each channel having
599 320 kHz and 32 tones, T0 through
600 T31, each tone being ~~10kHz~~ 10 kHz,
601 with the inner 30 tones being used
602 information bearing and T0 and T31
603 being reserved;
604 each signal being ~~100μs~~ 100 μs, with
605 ~~12.5μs~~ 12.5 μs at each end thereof at
606 the front and rear end thereof
607 forming respectively a cyclic prefix
608 and cyclic suffix buffer to punctuate
609 successive signals;
610 a MUX element for timing modification
611 capable of element-wise multiplication
612 across the signal, which halves the number
613 of bins and tones but repeats the signal for
614 high-quality needs;
615 a symbol-coding element for embedding the
616 symbols to be interpreted by the receiver in
617 the signal, further comprising:

647
648 said set of nodes being deployed according to design rules that prefer
649 meeting the following criteria:
650 said set of nodes further comprising two or more proper subsets of
651 nodes, with a first proper subset being the transmit uplink / receive
652 downlink set, and a second proper subset being the transmit
653 downlink / receive uplink set;
654
655 each node in said set of nodes belonging to no more transmitting
656 uplink or receiving uplink subsets than it has diversity capability
657 means;
658
659 each node in a transmit uplink / receive downlink subset has no
660 more nodes with which it will hold time and frequency coincident
661 communications in its field of view, than it has diversity capability
662 means;
663
664 each node in a transmit downlink / receive uplink subset has no
665 more nodes with which it will hold time and frequency coincident
666 communications in its field of view, than it has diversity capability
667 means;
668
669 each member of a transmit uplink / receive downlink subset cannot
670 hold time and frequency coincident communications with any
671 other member of that transmit uplink / receive downlink subset;
672
673 and,
674
675 each member of a transmit downlink / receive uplink subset cannot
676 hold time and frequency coincident communications with any
677 other member of that transmit downlink / receive uplink subset;

678
 679 transmitting, in said wireless electromagnetic communications network,
 680 independent information from each node belonging to a first proper subset, to one
 681 or more receiving nodes belonging to a second proper subset that are viewable
 682 from the transmitting node;
 683
 684 processing independently, in said wireless electromagnetic communications
 685 network, at each receiving node belonging to said second proper subset,
 686 information transmitted from one or more nodes belonging to said first proper
 687 subset;
 688
 689 and,
 690
 691 designing the network such that substantially reciprocal symmetry exists for the
 692 uplink and downlink channels by,
 693 if the received interference is spatially white in both link directions, setting
 694
 695 $\underline{g_1(a) \propto w_2^*(q)}$ and $\underline{g_2(q) \propto w_1^*(q)}$
 696 $\underline{g_2(q) \propto w_2^*(q)}$ and $\underline{g_1(q) \propto w_1^*(q)}$ at both ends of the link,
 697 where $\underline{\{g_2(q), w_1(q)\}}$ $\underline{\{g_2(q), w_1(q)\}}$ are the linear transmit
 698 and receive weights used in the downlink;
 699
 700 but if the received interference is not spatially white in both link
 701 directions, constraining $\underline{\{g_1(q)\}}$ and $\underline{\{g_2(q)\}}$
 702 $\underline{\{g_1(q)\}}$ and $\underline{\{g_2(q)\}}$ to satisfy:
 703
 704 $\underline{Q_{21}}$
 705 $\underline{\sum g_1^T(q) R_{1111} [n_1(q)] g_1^*(q) =}$

706 $\qquad \qquad \qquad q=1$

707 $\qquad \qquad \qquad N_1$

708
$$\sum \text{Tr}\{\mathbf{R}_{i_1 i_1}(n)\} = M_1 R_1$$

709 $\qquad \qquad \qquad n=1$

710

711 $\qquad \qquad \qquad Q_{i_2}$

712
$$\sum \mathbf{g}_2^T(q) \mathbf{R}_{i_2 i_2}[n_2(q)] \mathbf{g}_2^*(q) =$$

713 $\qquad \qquad \qquad q=1$

714 $\qquad \qquad \qquad n=1$

715
$$\sum \text{Tr}\{\mathbf{R}_{i_2 i_2}(n)\} = M_2 R_2;$$

716 $\qquad \qquad \qquad N_2$

717

718

719
$$\sum_{q=1}^{Q_{i_1}} \mathbf{g}_1^T(q) \mathbf{R}_{i_1 i_1}(n_1(q)) \mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \text{Tr}\{\mathbf{R}_{i_1 i_1}(n)\} = M_1 R_1$$

720

721
$$\sum_{q=1}^{Q_{i_2}} \mathbf{g}_2^T(q) \mathbf{R}_{i_2 i_2}(n_2(q)) \mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{i_2 i_2}(n)\} = M_2 R_2;$$

722

723 using any standard communications protocol, including TDD, FDD, simplex,

724

725 and,

726

727 optimizing the network by dynamically adapting the diversity channels capability
728 means between nodes of said transmitting and receiving subsets.

729

730

731

732 42. (original) A method as in claim 41, wherein said a transmission/reception switch
733 further comprises:

734

735 an element for tone and slot interleaving.

736

737 43. (original) A method as in claim 41, wherein said TMC codec and SOVA decoder are
738 replaced with a Turbo codec.

739

740 44. (currently amended) A method as in claim 1, wherein the step of
741 dynamically adapting the diversity ~~channels~~ capability means and said proper subsets to
742 optimize said network further comprises:
743 optimizing at each node acting as a receiver the receive weights using ~~the a~~
744 MMSE technique to adjust the multitone transmissions between it and other
745 nodes.

746

747

748 45. (currently amended) A method as in claim 1, wherein the step of dynamically
749 adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said
750 network further comprises:
751 optimizing at each node acting as a receiver the receive weights using the ~~MAX~~
752 maximum SINR to adjust the multitone transmissions between it and other nodes.

753

754

755 46. (currently amended) A method as in claim 1, wherein the step of dynamically
756 adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said
757 network further comprises:
758 optimizing at each node acting as a receiver the receive weights, then optimizing
759 the transmit weights at that node by making them proportional to the receive

760 weights, and then optimizing the transmit gains for that node by a max-min
761 criterion for the link capacities for that node at that particular time.

762

763

764 47. (currently amended) A method as in claim 1, wherein the step of dynamically
765 adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said
766 network further comprises:

767 including, as part of said network, one or more network controller elements that
768 assist in tuning local node's maximum ~~capacity~~ capacity criteria and link channel
769 diversity usage to network constraints.

770

771

772 48. (currently amended) A method as in claim 1, wherein the step of dynamically
773 adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said
774 network further comprises:

775 characterizing the channel response vector $\mathbf{a}_1(f,t;n_2, n_1)$ by the observed

776 (possibly time-varying) azimuth and elevation $\{\theta_1(t;n_2, n_1),$

777 $\varphi_1(f,t;n_2, n_1)\}$ of node n_2 observed at n_1 .

778

779 49. (currently amended) A method as in claim 1, wherein the step of dynamically
780 adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said
781 network further comprises:

782 characterizing the channel response vector $\mathbf{a}_1(f,t;n_2, n_1)$ as a superposition of
783 direct-path and near-field reflection path channel responses, e.g., due to scatterers
784 in the vicinity of n_1 , such that each element of $\mathbf{a}_1(f,t;n_2, n_1)$ can be modeled
785 as a random process, possibly varying over time and frequency.

786

787 50. (currently amended) A method as in claim 1, wherein the step of dynamically
788 adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said
789 network further comprises:

790 presuming that $\mathbf{a}_1(f, t; n_2, n_1)$ and $\mathbf{a}_1(f, t; n_{2[1]}, n_{4[2]})$ can be
791 substantively time invariant over significant time durations, e.g., large numbers of
792 OFDM symbols or TDMA time frames, and inducing the most significant
793 frequency and time variation by the observed timing and carrier offset on each
794 link.

795

796

797 51. (currently amended) A method as in claim 1, wherein the step of dynamically
798 adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said
799 network further comprises:

800 in such networks, e.g., TDD networks, wherein the transmit and receive
801 frequencies are identical ($f_{21}(k) = f_{12}(k) = f(k)$) and the transmit and
802 receive time slots are separated by short time intervals ($t_{21}(l) = t_{12}(l) + \Delta_{21}$
803 $\approx t(l)$), and $\mathbf{H}_{21}(k, l)$ and $\mathbf{H}_{12}(k, l)$ and $\underline{\mathbf{H}_{21}(k, l)}$ and
804 $\underline{\mathbf{H}_{12}(k, l)}$ become substantively reciprocal, such that the subarrays
805 comprising $\mathbf{H}_{21}(k, l)$ and $\mathbf{H}_{12}(k, l)$ $\underline{\mathbf{H}_{21}(k, l)}$ and $\underline{\mathbf{H}_{12}(k, l)}$ satisfy
806 $\mathbf{H}_{21}(k, l; n_2, n_1) \approx \delta_{21}(k, l; n_1, n_2) \underline{\mathbf{H}_{12}^T(k, l; n_1, n_2)}$,
807 where $\delta_{21}(k, l; n_1, n_2)$ is a unit-magnitude, generally nonreciprocal scalar,
808 equalizing the observed timing offsets, carrier offsets, and phase offsets, such that
809 $\lambda_{21}(n_2, n_1) \approx \lambda_{12}(n_1, n_2)$, $\tau_{21}(n_2, n_1) \approx \tau_{12}(n_{2\underline{1}}, n_{4\underline{2}})$, and
810 $\nu_{21}(n_1, n_2) \approx \nu_{12}(n_{2\underline{1}}, n_{4\underline{2}})$, by synchronizing each node to an external,

811 universal time and frequency standard, obtaining $\delta_{21}(k, l; n_{4[2]}, n_{2[1]}) \approx$
812 1, and establishing network channel response as truly reciprocal $\mathbf{H}_{21}(k, l) \approx$
813 $\underline{\mathbf{H}_{21}^T \mathbf{H}_{12}^T}(k, l).$

814
815
816 52. A method as in claim 51, wherein the synchronization of each node is to Global
817 Position System Universal Time Coordinates (GPS UTC).

818
819
820 53. (original) A method as in claim 51, wherein the synchronization of each node is to a
821 network timing signal.

822
823
824 54. (original) A method as in claim 51, wherein the synchronization of each node is to a
825 combination of Global Position System Universal Time Coordinates (GPS UTC) and a
826 network timing signal.

827
828
829 55. (currently amended) A method as in claim 1, wherein the step of dynamically
830 adapting the diversity ~~channels~~ capability means and said proper subsets to optimize said
831 network further comprises:

832 for such parts of the network where the internode channel responses possess
833 substantive multipath, such that $\mathbf{H}_{21}(k, l; n_2, n_1)$ and $\underline{\mathbf{H}_{21} \mathbf{H}_{12}}(k, l$
834 $; n_{2\underline{1}}, n_{4\underline{2}})$ have rank greater than unity, making the channel response
835 substantively reciprocal by:

836
837 (1) forming uplink and downlink transmit signals using the matrix formula
838 in EQ. 40

839 $\mathbf{s}_1(k, l; n_1) = \mathbf{G}_1(k, l; n_1) \mathbf{d}_1(k, l; n_1)$
 840 $\mathbf{s}_2(k, l; n_1) = \mathbf{G}_2(k, l; n_2) \mathbf{d}_2(k, l; n_2);$

841 (2) reconstructing the data intended for each receive node using the
 842 matrix formula in EQ. 41

843 $\mathbf{y}_1(k, l; n_1) = \mathbf{W}_1^H(k, l; n_1) \mathbf{x}_1(k, l; n_1)$
 844 $\mathbf{y}_2(k, l; n_2) = \mathbf{W}_2^H(k, l; n_2) \mathbf{x}_2(k, l; n_2);$

845 (3) developing combiner weights that $\{\mathbf{w}_1(k, l; n_2, n_1)\}$ and
 846 $\{\mathbf{w}_2(k, l; n_1, n_2)\}$ that substantively null data intended for
 847 recipients during the symbol recovery operation, such that for $n_1 \neq n_2$:

848 (4) developing distribution weights $\{\mathbf{g}_1(k, l; n_2, n_1)\}$ and
 849 $\{\mathbf{g}_2(k, l; n_1, n_2)\}$ that perform equivalent substantive nulling
 850 operations during transmit signal formation operations;

851 (5) scaling distribution weights to optimize network capacity and/or power
 852 criteria, as appropriate for the specific node topology and application
 853 addressed by the network;

854 (6) removing residual timing and carrier offset remaining after recovery of
 855 the intended network data symbols;

856 and

857 (7) encoding data onto symbol vectors based on the end-to-end SINR
 858 obtainable between each transmit and intended recipient node, and

859 decoding that data after symbol recovery operations, using channel coding
860 and decoding methods develop in prior art.

861

862 56. (currently amended) A method as in claim 1, wherein dynamically adapting the
863 diversity channels capability means and said proper subsets to optimize said network
864 further comprises:

865 forming substantively nulling combiner weights using an FFT-based least-squares
866 algorithms that adapt $\{\mathbf{w}_1(k, l; n_2, n_1)\}$ and $\{\mathbf{w}_2(k, l; n_1, n_2)\}$ to
867 values that minimize the mean-square error (MSE) between the combiner output
868 data and a known segment of transmitted pilot data;

869 applying the pilot data to an entire OFDM symbol at the start of an adaptation
870 frame comprising a single OFDM symbol containing pilot data followed by a
871 stream of OFDM symbols containing information data;

872 wherein the pilot data transmitted over the pilot symbol is preferably given by
873 ~~EQ. 44 and EQ. 45,~~

874
$$p_1(k; n_2, n_1) = d_1(k, 1; n_2, n_1)$$

875
$$= p_{01}(k) p_{21}(k; n_2) p_{11}(k; n_1)$$

876
$$p_2(k; n_1, n_2) = d_2(k, 1; n_1, n_2)$$

877
$$= p_{02}(k) p_{12}(k; n_1) p_{22}(k; n_2)$$

878 such that the “pseudodelays” $\delta_1(n_1)$ and $\delta_2(n_2)$ are unique to each transmit
879 node (in small networks), or provisioned at the beginning of communication with

880 any given recipient node (in which case each will be a function of n_1 and n_2),
881 giving each pilot symbol a pseudorandom component;

882 maintaining minimum spacing between any pseudodelays used to communicate
883 with a given recipient node that is larger than the maximum expected timing
884 offset observed at that recipient node, said spacing should also being an integer
885 multiple of $1/K$, where K is the number of tones used in a single FFT-based LS
886 algorithm;

887 and if K is not large enough to provide a sufficiency of pseudodelays, using
888 additional OFDM symbols for transmission of pilot symbols, either lengthening
889 the effective value of K , or reducing the maximum number of originating nodes
890 transmitting pilot symbols over the same OFDM symbol;

891 also providing K large enough to allow effective combiner weights to be
892 constructed from the pilot symbols alone;

893 then obtaining the remaining information-bearing symbols, which are the uplink
894 and downlink data symbols provided by prior encoding, encryption, symbol
895 randomization, and channel preemphasis stages, in the adaptation frame, by using
896 EQ. 46 and EQ. 47

$$897 \quad d_1(k, l; n_2, n_1) = p_1(k; n_2, n_1) d_{01}(k, l; n_2, n_1)$$

$$898 \quad d_2(k, l; n_1, n_2) = p_2(k; n_1, n_2) d_{02}(k, l; n_1, n_2);$$

899 removing at the recipient node, first the pseudorandom pilot components from the
900 received data by multiplying each tone and symbol by the pseudorandom
901 components of the pilot signals, using EQ. 47 and EQ. 48

902 $d_2(k, l; n_1, n_2) = p_2(k; n_1, n_2) d_{02}(k, l; n_1, n_2)$

903 $\mathbf{x}_{02}(k, l; n_2) = c_{01}(k; n_2) \mathbf{x}_2(k, l; n_2);$

904 thereby transforming each authorized and intended pilot symbol for the recipient
905 node into a complex sinusoid with a slope proportional to the sum of the
906 pseudodelay used during the pilot generation procedure, and the actual observed
907 timing offset for that link, and leaving other, unauthorized pilot symbols, and
908 symbols intended for other nodes in the network, untransformed and so appearing
909 as random noise at the recipient node.

910

911

912 57. (currently amended) A method as in claim 55, wherein the FFT-Least Squares
913 algorithm is that shown in Figure 37, further comprises:
914 using a pilot symbol, which is multiplied by a unit-norm FFT window function;
915 passing that result to a QR decomposition algorithm and computing orthogonalized
916 data $\{\mathbf{q}(k)\}$ and an upper-triangular Cholesky statistics matrix \mathbf{R} ;
917 then multiplying each vector element of $\{\mathbf{q}(k)\}$ by the same unit-norm FFT
918 window function and passing it through a zero-padded inverse Fast Fourier
919 Transform (IFFT) with output length PK , with padding factor P to form
920 uninterpolated, spatially whitened processor weights $\{\mathbf{u}(m)\}$, where lag index
921 m is proportional to target pseudodelay $\delta(m) = m/PK$;
922 then using the spatially whitened processor weights to estimate the mean-square-
923 error (MSE) obtaining for a signal received at each target pseudodelay,
924 $\varepsilon(m) = 1 - \|\mathbf{u}(m)\|^2$, yielding a detection statistic (pseudodelay indicator
925 function), with an extreme at IFFT lags commensurate with the observed

926 pseudodelay and designed to minimize interlag interference between pilot signal
927 features in the pseudodelay indicator function;
928 using an extremes-finding algorithm to detect each extreme;
929 estimating the location of the observed pseudodelays to sub-lag accuracy;
930 determining additional ancillary statistics;
931 selecting the extremes beyond a designated MSE threshold;
932 interpolating spatially whitened weights \mathbf{U} from weights near the extremes;
933 using the whitened combiner weights \mathbf{U} to calculate both unwhitened combiner
934 weights $\mathbf{W} = \mathbf{R}^{-1} \mathbf{U}$ to be used in subsequent data recovery operations, and to
935 estimate the received channel aperture matrix $\mathbf{A} = \mathbf{R}^H \mathbf{U}$, to facilitate ancillary
936 signal quality measurements and fast network entry in future adaptation frames;
937 and, lastly,
938 using an estimated and optimized pseudodelay vector $\boldsymbol{\delta}_*$ to generate $\mathbf{c}_1(k) =$
939 $\exp\{-j2\pi\boldsymbol{\delta}_*k\}$ (conjugate of $\{p_{11}(k; n_1)\}$ during uplink receive
940 operations, and $\{p_{22}(k; n_2)\}$ during downlink receive operations), which is then
941 used to remove the residual observed pseudodelay from the information bearing
942 symbols.

943
944

945 58. (original) A method as in claim 55, wherein the pseudodelay estimation is refined
946 using a Gauss-Newton recursion using the approximation :

$$947 \quad \exp\{-j2\pi\Delta(k-k_0)/PK\} \approx 1 - j2\pi\Delta(k-k_0)/PK.$$

948
949

950 59. (currently amended) A method as in claim 1, wherein wherein dynamically
951 adapting the diversity channels capability means and said proper subsets to optimize said
952 network further comprises:

953 using the linear combiner weights provided during receive operations are
954 construct linear distribution weights during subsequent transmit operations, by
955 setting distribution weight $\mathbf{g}_1(k, l; n_2, n_1)$ proportional to
956 $\mathbf{w}^*_1(k, l; n_2, n_1)$ during uplink transmit operations, and
957 $\mathbf{g}_2(k, l; n_1, n_2)$ proportional to $\mathbf{w}^*(k, l; n_1, n_2)$ during downlink
958 transmit operations; thereby making the transmit weights substantively nulling
959 and thereby allowing each node to form frequency and time coincident two-way
960 links to every node in its field of view, with which it is authorized (through
961 establishment of link set and transfer of network/recipient node information) to
962 communicate.

963

964

965 60. (original) A method as in claim 1, wherein each node in the first subset of nodes
966 further comprises:

967 a LEGO implementation element and algorithm.

968

969

970 61. (currently amended) A method as in claim 1, wherein dynamically adapting the
971 diversity channels capability means and said proper subsets to optimize said network
972 further comprises:

973 balancing the power use against capacity for each channel, link, and node, and
974 hence for the network as a whole by:

975 establishing a capacity objective $\mathbf{B} \ \{\beta(m)\}$ for a particular Node 2
976 user 2 node receiving from a user 1 node another Node 1 as the target to
977 be achieved by the user 2 node node 2;

978 solving, at the user 2 node Node 2 the local optimization problem:

979 $\min \sum_q \pi_1(q) = \underline{1^T \boldsymbol{\pi}_1}$, such that

980 $\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m),$

981 where $\pi_1(q)$ is the SU (user 1 node) transmit power for link

982 number q for the user 1 node,

983 $\gamma(q)$ is the signal to interference and noise ratio (SINR) seen at
984 the output of the beamformer,

985 $\underline{1}$ is a vector of all 1s,

986 and,

987 $\boldsymbol{\pi}_1$ is a vector whose q^{th} element is $\pi_1(q)$ q^{th} element is $\pi_1(q)$,

988 the aggregate set $Q(m)$ $Q(m)$ contains a set of links that are
989 grouped together for the purpose of measuring capacity flows
990 through those links;

991 using at Node 2 the user 2 node the local optimization solution to
992 moderate the transmit and receive weights, and signal information,
993 returned to node 1 user 1 node;

994 and,

995 using said feedback to compare against the capacity objective B
996 $\{\beta(m)\}$ and incrementally adjust the transmit power at each of Node 1
997 the user 1 node and Node 2 the user 2 node until no further improvement
998 is perceptible.

999

1000

1001 62. (currently amended) A method as in claim 1, wherein dynamically adapting the
1002 diversity channels capability means and said proper subsets to optimize said network
1003 further comprises:

1004 using the downlink objective function ~~in EQ. 5 and EQ. 6~~

1005 $\min \sum_q \pi_2(q) = \mathbf{1}^T \boldsymbol{\pi}_2$ such that $\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq$
1006 $\beta(m)$

1007 at each node to perform local optimization;

1008 reporting the required feasibility condition, $\sum_{q \in Q(m)} \pi_1(q) \leq R_1(m)$

1009 $\sum_{q \in Q(m)} \pi_1(q) \leq R_1(m)$;

1010 and,

1011 modifying $\beta(m)$ as necessary to stay within the constraint.

1012

1013

1014 63. (original) A method as in claim ~~60~~ 61, wherein:

1015 the capacity constraints $\beta(m)$ are determined in advance for each proper subset
1016 of nodes, based on known QoS requirements for each said proper subset.

1017

1018

1019 64. (currently amended) A method as in claim ~~60~~ 61, wherein said network further
1020 seeks to minimize total power in the network as suggested by ~~EQ.~~ 4

1021 $\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m).$

1022

1023

1024 65. (currently amended) A method as in claim ~~60~~ 61, wherein said network sets as a
1025 target objective for the network \mathbf{B} $\{\beta(m)\}$ the QoS for the network.

1026

1027

1028 66. (currently amended) A method as in claim 60 61, wherein said network sets as a
1029 target objective for the network \mathbf{B} $\{\beta(m)\}$ a vector of constraints.

1030

1031

1032 67. (currently amended) A method as in claim 60 61, wherein the local optimization
1033 problem is further defined such that:

1034

1035 the receive and transmit weights are unit normalized with respect to the
1036 background interference autocorrelation matrix;

1037

1038 the local SINR is expressed as ~~EQ. 8~~

$$\gamma(q) = \frac{P_{rt}(q, q)\pi_t(q)}{1 + \sum_{j \neq q} P_{rt}(q, j)\pi_t(j)}$$

1039

1040

1041 and the weight normalization in ~~EQ. 6~~

$$\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)$$

1043

is used to enable $D_{12}(\mathbf{W}, \mathbf{G}) = D_{21}(\mathbf{G}^*, \mathbf{W}^*)$, where $(\mathbf{W}_2, \mathbf{G}_1)$
and $(\mathbf{W}_1, \mathbf{G}_2)$ represent the receive and transmit weights employed by all
nodes in the network during uplink and downlink operations, respectively, the
reciprocity equation at that node, thereby allowing the uplink and downlink
function to be presumed identical rather than separately computed.

1048

1049

1050 68. (currently amended) A method as in claim 60 61, wherein:
1051 very weak constraints to the transmit powers are approximated by using a very
1052 simple approximation for $\gamma(q)$ $\underline{\gamma}(q)$.

1053
 1054
 1055 69. (currently amended) A method as in claim 60 61, for the cases wherein all the
 1056 aggregate sets contain a single link and non-negligible environmental noise is present,
 1057 wherein the transmit powers are computed as Perron vectors from EQ. 10,

$$D_{21} = \log \left(1 + \frac{1}{\rho(\mathbf{P}_{21}) - 1} \right)$$

$$= \log \left(1 + \frac{1}{\rho(\mathbf{P}_{12}^T) - 1} \right) ;$$

$= D_{12}$

1059 and a simple power constraint is imposed upon the transmit powers.

1060
 1061
 1062 70. (currently amended) A method as in claim 60 69, wherein the optimization is
 1063 performed in alternating directions and repeated.

1064
 1065
 1066 71. (currently amended) A method as in claim 60-61, wherein each node presumes
 1067 the post-beamforming interference energy remains constant for the adjustment interval
 1068 and so solves EQ. 3

$$\min_{\pi_1(q)} \sum_q \pi_1(q) = \mathbf{1}^T \boldsymbol{\pi}_1 \quad \text{subject to the constraint of}$$

$$\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)$$

1071 using classic water filling arguments based on Lagrange multipliers, and then uses a
 1072 similar equation for the reciprocal element of the link.

1073

1074
1075 72. (currently amended) A method as in claim 60 61, wherein at each node the
1076 constrained optimization problem stated in ~~EQ. 13 and 14~~

1077 $\max_m \sum_{q \in Q(m)} \log(1 + \gamma(q))$, such that

$$\underline{\sum_{q \in Q(m)} \pi_1(q) \leq R_1(m), \gamma(q) \geq 0}$$

1079 is solved using the approximation in ~~EQ. 11~~,

$$\underline{\gamma(q) = \frac{P_{21}(q, q)\pi_1(q)}{i_2(q)}}$$

1081 and the network further comprises at least one high-level network controller that controls
1082 the power constraints ~~R₄(q)~~ R₁(m), and drives the network towards a max-min
1083 solution.

1084

1085

1086 73. (currently amended) A method as in claim 60 61, wherein each node:

1087 is given an initial γ_0 ;

1088 generates the model expressed in ~~EQ. 20, EQ. 21, and EQ. 22~~

$$\underline{L(\gamma, g, \beta) = g^T \gamma, \sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)}$$

$$\underline{g = \nabla_\gamma f(\gamma_0)} ;$$

1091 updates the new γ_α from ~~EQ. 23 and EQ. 24~~

$$\underline{\gamma_* = \arg \min_\gamma L(\gamma, g, \beta), \gamma_\alpha = \gamma_0 + \alpha(\gamma_* - \gamma_0)} ;$$

1093 determines a target SINR to adapt to; and,

1094 updates the transmit power for each link q according to ~~EQ. 25 and EQ. 26~~

$$\underline{\pi_2(q) = \gamma_\alpha i_1(q) / |h(q)|^2}$$

1096 $\pi_1(q) = \gamma_\alpha i_2(q) / |h(q)|^2$

1097

1098 74. (currently amended) A method as in claim 60 61, for each node wherein the
1099 transmit power relationship of ~~EQ. 25 and EQ. 26~~

1100 $\pi_2(q) = \gamma_\alpha i_1(q) / |h(q)|^2$

1101 $\pi_1(q) = \gamma_\alpha i_2(q) / |h(q)|^2$

1102 is not known, that:

1103 uses a suitably long block of N samples is used to establish the relationship, where
1104 N is either 4 times the number of antennae or 128, whichever is larger;
1105 uses the result to update the receive weights at each end of the link;
1106 optimizes the local model as in ~~EQ. 23 and EQ. 24~~

1107 $\gamma_* = \arg \min_{\gamma} L(\gamma, \mathbf{g}, \beta)$

1108 $\gamma_\alpha = \gamma_0 + \alpha(\gamma_* - \gamma_0)$;

1109 and then applies

1110 $\pi_2(q) = \gamma_\alpha i_1(q) / |h(q)|^2$

1111 $\pi_1(q) = \gamma_\alpha i_2(q) / |h(q)|^2$ ~~EQ. 25 and EQ. 26.~~

1112

1113 75. (currently amended) A method as in claim 60 61 that, for an aggregate proper
1114 subset m :

1115 for each node within the set m , inherits the network objective function model
1116 given in ~~EQ. 28, EQ. 29, and EQ. 30~~

1117 $L_m(\gamma, \mathbf{g}, \beta) = \sum_{q \in Q(m)} \mathbf{g}_q \gamma(q)$

1118 $\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)$

1119
$$g(q) = i_1(q)i_2(q) / |h(q)|^2 ;$$

1120 eliminates the a step of matrix channel estimation, transmitting instead
 1121 from that node as a single real number for each link to the other end of
 1122 said link an estimate of the post beamforming interference power;
 1123 and ,
 1124 receives back for each link a single real number being the transmit power.

1125

1126 76. (original) A method as in claim 75 74 , that for each pair of nodes assigns to the one
 1127 presently possessing the most processing capability the power management
 1128 computations.

1129

1130

1131 77. (currently amended) A method as in claim 74 75 that estimates the transfer gains
 1132 and the post beamforming interference power using simple least squares estimation
 1133 techniques.

1134

1135

1136 78. (currently amended) A method as in claim 74 75 that, for estimating the transfer
 1137 gains and post beamforming interference power:

1138

1139 instead solves for the transfer gain h using EQ. 31

1140
$$y(n) = hgs(n) + \varepsilon(n);$$

1141 uses a block of N samples of data to estimate h using EQ. 32

1142
$$h = \frac{\sum_{n=1}^N s^*(n)y(n)}{\sum_{n=1}^N |s(n)|^2 g} ;$$

1143 obtains an estimation of residual interference power \underline{R}_e $\underline{R}_\varepsilon$ using EQ. 33

1144

$$R_\varepsilon = \left\langle |\varepsilon(n)|^2 \right\rangle ;$$

$$= \frac{1}{N} \sum_{n=1}^N \left(|y(n)|^2 - |ghs(n)|^2 \right)$$

1145 and,

1146 obtains knowledge of the transmitted data symbols $S(n)$ from using
1147 remodulated symbols at the output of the codec.

1148

1149

1150 79. (currently amended) A method as in claim ~~77~~ 78 wherein, instead of obtaining
1151 knowledge of the transmitted data symbols $S(n)$ from using remodulated symbols at the
1152 output of the codec, the node uses the output of a property restoral algorithm used in a
1153 blind beamforming algorithm.

1154

1155

1156 80. (currently amended) A method as in claim ~~77~~ 78 wherein, instead of obtaining
1157 knowledge of the transmitted data symbols $S(n)$ from using remodulated symbols at the
1158 output of the codec, the node uses a training sequence explicitly transmitted to train
1159 beamforming weights and asset the power management algorithms.

1160

1161

1162 81. (currently amended) A method as in claim ~~77~~ 78 wherein, instead of obtaining
1163 knowledge of the transmitted data symbols $S(n)$ from using remodulated symbols at the
1164 output of the codec, the node uses any combination of:
1165 the output of a property restoral algorithm used in a blind beamforming algorithm;
1166 a training sequence explicitly transmitted to train beamforming weights and asset
1167 the power management algorithms;
1168 or,

- 1169 other means known to the art.
- 1170
- 1171
- 1172 82. (currently amended) A method as in claim 60 61, wherein each node
1173 incorporates a link level optimizer and a decision algorithm, as illustrated in Figure
1174 32A and 32B.
- 1175
- 1176 83. (currently amended) A method as in claim 81 82, wherein the decision
1177 algorithm is a Lagrange multiplier technique.
- 1178
- 1179
- 1180 84. (currently amended) A method as in claim 60 61, wherein the solution to EQ.3
1181
$$\min_{\pi_1(q)} \sum_q \pi_1(q) = \mathbf{1}^T \boldsymbol{\pi}_1$$
 is implemented by a penalty function technique.

- 1182
- 1183
- 1184 85. (currently amended) A method as in claim 83 84, wherein the penalty function
1185 technique:
1186 takes the derivative of $\gamma(q)$ $\gamma(q)$ with respect to π_1 ;
1187 and,
1188 uses the Kronecker-Delta function and the weighted background noise.
- 1189
- 1190
- 1191 86. (currently amended) A method as in claim 83 84, wherein the penalty function
1192 technique neglects the noise term.
- 1193
- 1194
- 1195 87. (currently amended) A method as in claim 83 84, wherein the penalty function
1196 technique normalizes the noise term to one.
- 1197

1198
1199 88. (currently amended) A method as in claim 60 61, wherein the approximation
1200 uses the receive weights.
1201
1202
1203 89. (currently amended) A method as in claim 60 61, wherein adaptation to the
1204 target objective is performed in a series of measured and quantized descent and ascent
1205 steps.
1206
1207 90. (currently amended) A method as in claim 60 61, wherein the adaptation to the
1208 target objective is performed in response to information stating the vector of change.
1209
1210
1211 91. (currently amended) A method as in claim 60 61, which uses the log linear mode
1212 in EQ. 34

1213

$$\beta_q \approx \log\left(\frac{a \pi_1(q) + a_0}{b \pi_1(q) + b_0}\right) = \hat{\beta}_q(\pi_1(q))$$

1214 and the inequality characterization in EQ. 35 $\hat{\beta}_q(\pi_1(q)) \geq \beta$ to solve the
1215 approximation problem with a simple low dimensional linear program.
1216
1217

1218 92. (currently amended) A method as in claim 60 61, develops the local mode by
1219 matching function values and gradients between the current model and the actual
1220 function.
1221
1222
1223 93. (currently amended) A method as in claim 60 61, which develops the model as a
1224 solution to the least squares fit, evaluated over several points.
1225

- 1226
- 1227 94. (currently amended) A method as in claim ~~60~~ 61, which reduces the cross-
1228 coupling effect by allowing only a subset of links to update at any one particular time,
1229 wherein the subset members are chosen as those which are more likely to be isolated
1230 from one another.
- 1231
- 1232
- 1233
- 1234 95. (currently amended) A method as in claim ~~60~~ 61, wherein:
1235 the network further comprises a network controller element;
1236 said network controller element governs a subset of the network;
1237 said network controller element initiates, monitors, and changes the target
1238 objective for that subset;
1239 said network controller communicates the target objective to each node in that
1240 subset;
1241 and,
1242 receives information from each node concerning the adaptation necessary to meet
1243 said target objective.
- 1244
- 1245
- 1246 96. (currently amended) A method as in claim ~~94~~ 95, wherein said network further
1247 records the scalar and history of the increments and decrements ordered by the network
1248 controller.
- 1249
- 1250
- 1251 97. (currently amended) A method as in claim ~~60~~ 61, wherein for any subset, a target
1252 objective may be a power constraint.
- 1253
- 1254
- 1255 98. (currently amended) A method as in claim ~~60~~ 61, wherein for any subset, a target
1256 objective may be a capacity maximization subject to a power constraint.

1257

1258

1259 99. (currently amended) A method as in claim 60 61, wherein for any subset, a
1260 target objective may be a power minimization subject to the capacity attainment to the
1261 limit possible over the entire network.

1262

1263

1264 100. (currently amended) A method as in claim 60 61, wherein for any subset, a
1265 target objective may be a power minimization at each particular node in the network
1266 subject to the capacity constraint at that particular node.

1267

1268

1269 101. (currently amended) A wireless electromagnetic communications network,
1270 comprising:
1271 a wireless electromagnetic communications network, comprising
1272 a set of nodes, said set further comprising,
1273 at least a first subset wherein each node is MIMO-capable,
1274 comprising:
1275 a spatially diverse antennae array of M antennae, where M
1276 ≥ one,
1277 a transceiver for each antenna in said array,
1278 means for digital signal processing,
1279 means for coding and decoding data and symbols,
1280 means for diversity transmission and reception,
1281 and,
1282 means for input and output from and to a non-radio
1283 interface;
1284 said set of nodes further comprising one or more proper subsets of nodes,
1285 being at least one transmitting and at least one receiving subset, with said
1286 transmitting and receiving subsets having a topological arrangement
1287 whereby:

1288 each node in a transmitting subset has no more nodes with which it
1289 will simultaneously communicate in its field of view, than it has
1290 number of antennae;

1291 each node in a receiving subset has no more nodes with which it
1292 will simultaneously communicate in its field of view, than it can
1293 steer independent nulls to;

1294 and,

1295 each member of a non-proper subset cannot communicate with any
1296 other member of its non-proper subset;

1297 transmitting independent information from each node in a first non-proper subset
1298 to one or more receiving nodes belonging to a second non-proper subset that are
1299 viewable from the transmitting node;

1300 processing independently information transmitted to a receiving node in a second
1301 non-proper subset from one or more nodes in a first non-proper subset is
1302 independently by the receiving node;

1303 and,

1304 optimizing the network by dynamically adapting the ~~diversity channels~~ means for
1305 between nodes of said transmitting and receiving
1306 subsets.

1307

1308

1309 102. (currently amended) An apparatus as in claim 400 101, further
1310 comprising an element for scheduling according to a Demand-Assigned, Multiple-Access
1311 algorithm.

1312

1313

1314 103. (currently amended) An apparatus as in claim 400 101, further comprising for
1315 each node in said first subset a LEGO adaptation element.

1316

1317

1318 104. (currently amended) An apparatus as in claim 400 101, further comprising:

1319 for each node in said first subset a LEGO adaptation element; and,
1320 one or more network controllers.

1321

1322

1323 105. (currently amended) A method as in claim 1, wherein the step of dynamically
1324 adapting the diversity channels capability means and said proper subsets to optimize said
1325 network further comprises:

1326

1327 matching each transceiver's degrees of freedom (DOF) to the nodes in the
1328 possible link directions;

1329 equalizing those links to provide node-equivalent uplink and downlink capacity.

1330

1331 106. (original) A method as in claim 105, further comprising, after the DOF matching:
1332 assigning asymmetric transceivers to reflect desired capacity weighting;
1333 adapting the receive weights to form a solution for multipath resolutions;
1334 employing data and interference whitening as appropriate to the local conditions;
1335 and,
1336 using retrodirective transmission gains during subsequent transmission operations.

1337

1338

1339 107. (original) A method as in claim 105, wherein the receive weights are similarly-
1340 modified matched to the nodes in the possible link directions.

1341

1342

1343 108. (currently amended) A method for optimizing a wireless electromagnetic
1344 communications network, comprising:
1345 a wireless electromagnetic communications network, comprising
1346 a set of nodes, said set of nodes further comprising,
1347 at least a first subset wherein each node is MIMO-capable,
1348 comprising:
1349 an antennae array of M M ≥ one,

1381 communications in its field of view, than it has diversity capability
1382 means;

1383

1384 each member of a transmit uplink / receive downlink subset cannot
1385 hold time and frequency coincident communications with any
1386 other member of that transmit uplink / receive downlink subset;

1387 and,

1388 each member of a transmit downlink / receive uplink subset cannot
1389 hold time and frequency coincident communications with any
1390 other member of that transmit downlink / receive uplink subset;

1391

1392 transmitting, in said wireless electromagnetic communications network,
1393 independent information from each node belonging to a first proper subset, to one
1394 or more receiving nodes belonging to a second proper subset that are viewable
1395 from the transmitting node;

1396

1397 processing independently, in said wireless electromagnetic communications
1398 network, at each receiving node belonging to said second proper subset,
1399 information transmitted from one or more nodes belonging to said first proper
1400 subset;

1401

1402 optimizing at the local level for each node for the channel capacity \mathbf{D}_{21}
1403 according to ~~EQ.~~ 49,

$D_{21} = \max \beta$ such that

$$\beta \leq \sum_{q \in U(m)} \sum_k \log(1 + \gamma(k, q)),$$

$$\gamma(k, q) \geq 0,$$

1404 $\sum_m R_1(m) \leq R,$;

$$\pi_1(k, q) \geq 0,$$

$$\sum_{q \in U(m)} \sum_k \pi_1(k, q) \leq R_1(m)$$

1405 solving first the reverse link power control problem; then treating the forward link
1406 problem in an identical fashion, substituting the subscripts 2 for 1 in said
1407 equation;

1408 and,

1409 dynamically adapting the diversity channels capability means and said proper
1410 subsets to optimize said network.

1411

1412

1413 109. (currently amended) A method as in claim 108, further comprising:

1414

1415 for each aggregate subset m , attempting to achieve the given capacity objective, β
1416 β , as described in

1417
$$\min_{\pi_r(q)} \sum_{q \in Q(m)} \pi_r(q), \text{ such that}$$

1418
$$\beta = \sum_{q \in Q(m)} \log(1 + \gamma(q))$$

1419

1420 EQ. 50, by:

- (1) optimizing the receive beamformers, using simple MMSE processing, to simultaneously optimize the SINR;
- (2) based on the individual measured SINR for each q index, attempt to incrementally increase or lower its capacity as needed to match the current target; and,
- (3) ~~stepping~~ stepping the power by a quantized small step in the appropriate direction;

then,

when all aggregate sets have achieved the current target capacity, then the network can either increase the target capacity β , or add additional users to exploit the now-known excess capacity.

110. (currently amended) A method as in claim 106 107, wherein instead of optimizing for channel [capability means] capacity, the network optimizes for QoS and not diversity capability means capacity.

111. (currently amended) A method as in claim 94 95, wherein:
said network controller adds, drops, or changes the target capacity for any node in
the set the network controller controls.

112. (currently amended) A method as in claim 94 95, wherein:

said network controller may, either in addition to or in replacement for altering β , add, drop, or change channels between nodes, frequencies, coding, security, or protocols, polarizations, or traffic density allocations usable by a particular node or channel.

1450 113. (currently amended) A wireless electromagnetic communications network,
1451 comprising:
1452 a set of nodes, said set further comprising,
1453 at least a first subset wherein each node is MIMO-capable,
1454 comprising:
1455 a spatially diverse antennae array of M M antennae, where
1456 M M ≥ one,
1457 a transceiver for each antenna in said array,
1458 +3 means for digital signal processing,
1459 +4 means for coding and decoding data and symbols,
1460 +9 means for diversity transmission and reception,
1461 pilot symbol coding & decoding element
1462 timing synchronization element
1463 and,
1464 means for input and output from and to a non-radio
1465 interface;
1466 said set of nodes further comprising two or more proper subsets of nodes,
1467 there being at least one transmitting and at least one receiving subset, with
1468 said transmitting and receiving subsets subset having a diversity
1469 arrangement whereby:
1470 each node in a transmitting subset has no more nodes with which it
1471 will simultaneously communicate in its field of view, than it has
1472 number of antennae;
1473 each node in a receiving subset has no more nodes with which it
1474 will simultaneously communicate in its field of view, than it can
1475 steer independent nulls to;
1476 and,
1477 each member of a non-proper subset cannot communicate with any
1478 other member of its non-proper subset over identical diversity
1479 channels;
1480 a LEGO adaptation element and algorithm;

1481 a network controller element and algorithm;
 1482 whereby each node in a first non-proper subset transmits independent information
 1483 to one or more receiving nodes belonging to a second non-proper subset that are
 1484 viewable from the transmitting node;
 1485 each receiving node in said second non-proper subset processes independently
 1486 information transmitted to it from one or more nodes in a first non-proper subset is
 1487 independently by the receiving node;
 1488 each node uses means to minimize SINR between nodes transmitting and
 1489 receiving information;
 1490 the network is designed such that substantially reciprocal symmetry exists for the
 1491 uplink and downlink channels by,
 1492 if the received interference is spatially white in both link directions, setting
 1493 $\mathbf{g}_1(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_2(q) \propto \mathbf{w}_1^*(q)$
 1494 $\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)$ at both ends of the link,
 1495 where $\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$ $\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$ are the linear transmit
 1496 and receive weights used in the downlink;
 1497
 1498 but if the received interference is not spatially white in both link
 1499 directions, constraining $\{\mathbf{g}_1(q)\}$ and $\{\mathbf{g}_2(q)\}$
 1500 $\{\mathbf{g}_1(q)\}$ and $\{\mathbf{g}_2(q)\}$ to satisfy:
 1501 \mathbf{Q}_{24}
 1502 $\sum \mathbf{g}_1^T(q) \mathbf{R}_{ihi} [\mathbf{n}_1(q)] \mathbf{g}_1^*(q) =$
 1503 $q=1$
 1504 N_1
 1505 $\sum \text{Tr}\{\mathbf{R}_{ihi}(n)\} = M_1 R_{11}$
 1506 $n=1$

1507

1508 \mathbf{Q}_{12}

1509 $\sum \mathbf{g}_2^T(\mathbf{q}) \mathbf{R}_{i_2 i_2}[\mathbf{n}_2(\mathbf{q})] \mathbf{g}_2^*(\mathbf{q}) =$

1510 $\frac{1}{q=1}$

1511 $\frac{1}{n=1}$

1512 $\sum \text{Tr}\{\mathbf{R}_{i_2 i_2}(n)\} = M_2 R_2,$

1513 $\frac{1}{N_2}$

1514

1515 $\sum_{q=1}^{Q_{21}} \mathbf{g}_1^T(q) \mathbf{R}_{i_1 i_1}(n_1(q)) \mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \text{Tr}\{\mathbf{R}_{i_1 i_1}(n)\} = M_1 R_1$

1516 $\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q) \mathbf{R}_{i_2 i_2}(n_2(q)) \mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{i_2 i_2}(n)\} = M_2 R_2$

1517 ;

1518 the network uses any standard communications protocol;

1519 and,

1520 the network is optimized by dynamically adapting the means for diversity

1521 transmission and reception diversity channels between nodes of said transmitting
1522 and receiving subsets.

1523

1524

1525 114. (currently amended) A wireless electromagnetic communications network as in
1526 claim 112 113:

1527 wherein each node may further comprise a Butler Mode Forming element, to
1528 enable said node to ratchet the number of active antennae for a particular uplink
1529 or downlink operation up or down.

1530

1531

- 1532 115. (currently amended) A wireless electromagnetic communications network as in
1533 claim 50 101:
1534 incorporating a dynamics-resistant multitone element.
1535
1536
1537 116. (original) The use of a method as described in claim 1 for fixed wireless
1538 electromagnetic communications.
1539
1540 117. (currently amended) The use of an apparatus as described in claim 50 101 for
1541 fixed wireless electromagnetic communications.
1542
1543 118. (original) The use of a method as described in claim 1 for mobile wireless
1544 electromagnetic communications.
1545
1546 119. (currently amended) The use of an apparatus as described in claim 50 101 for
1547 mobile wireless electromagnetic communications.
1548
1549 120. (original) The use of a method as described in claim 1 for mapping operations using
1550 wireless electromagnetic communications.
1551
1552 121. (currently amended) The use of an apparatus as described in claim 50 101 for
1553 mapping operations using wireless electromagnetic communications.
1554
1555 122. (original) The use of a method as described in claim 1 for a military wireless
1556 electromagnetic communications network.
1557
1558 123. (currently amended) The use of an apparatus as described in claim 50 101 for a
1559 military wireless electromagnetic communications network.
1560
1561 124. (original) The use of a method as described in claim 1 for a military wireless
1562 electromagnetic communications network for battlefield operations.

- 1563
- 1564 125. (currently amended) The use of an apparatus as described in claim 50 101 for a
1565 military wireless electromagnetic communications network for battlefield operations.
- 1566
- 1567 126. (original) The use of a method as described in claim 1 for a military wireless
1568 electromagnetic communications network for Back Edge of Battle Area (BEBA)
1569 operations.
- 1570
- 1571 127. (original) The use of an apparatus as described in claim 50 101 for a military
1572 wireless electromagnetic communications network for Back Edge of Battle Area (BEBA)
1573 operations..
- 1574
- 1575 128. (original) The use of a method as described in claim 1 for a wireless electromagnetic
1576 communications network for intruder detection operations.
- 1577
- 1578 129. (original) The use of an apparatus as described in claim 50 101 for a wireless
1579 electromagnetic communications network for intruder detection operations.
- 1580
- 1581 130. (original) The use of a method as described in claim 1 for a wireless electromagnetic
1582 communications network for logistical intercommunications.
- 1583
- 1584 131. (original) The use of an apparatus as described in claim 50 101 for a wireless
1585 electromagnetic communications network for logistical intercommunications.
- 1586
- 1587 132. (original) The use of a method as described in claim 1 in a wireless electromagnetic
1588 communications network for self-filtering spoofing signals.
- 1589
- 1590 133. (original) The use of an apparatus as described in claim 50 101 for a wireless
1591 electromagnetic communications network for self-filtering spoofing signals.
- 1592

- 1593 134. (original) The use of a method as described in claim 1 in a wireless
1594 electromagnetic communications network for airborne relay over the horizon.
- 1595
- 1596 135. (original) The use of an apparatus as described in claim ~~50~~ 101 for a wireless
1597 electromagnetic communications network for airborne relay over the horizon.
- 1598
- 1599 136. (original) The use of a method as described in claim 1 in a wireless electromagnetic
1600 communications network for traffic control.
- 1601
- 1602 137. (currently amended) The use of a method as in claim ~~166~~ 1, further comprising
1603 the use thereof for air traffic control.
- 1604
- 1605 138. (currently amended) The use of a method as in claim ~~166~~ 1, further comprising
1606 the use thereof for ground traffic control.
- 1607
- 1608 139. (currently amended) The use of a method as in claim ~~166~~ 1, further comprising
1609 the use thereof for a mixture of ground and air traffic control.
- 1610
- 1611 140. (original) The use of an apparatus as described in claim ~~50~~ 101 for a wireless
1612 electromagnetic communications network for traffic control.
- 1613
- 1614 141. (currently amended) The use of an apparatus as in claim ~~170~~ 101, further
1615 comprising the use thereof for air traffic control
- 1616
- 1617 142. (currently amended) The use of an apparatus as in claim ~~170~~ 101, further
1618 comprising the use thereof for ground traffic control.
- 1619
- 1620 143. (currently amended) The use of an apparatus as in claim ~~170~~ 101, further
1621 comprising the use thereof for a mixture of ground and air traffic control.
- 1622

- 1623 144. (original) The use of a method as in claim 1 in a wireless electromagnetic
1624 communications network for emergency services.
- 1625
- 1626 145. (original) The use of an apparatus as in claim 50 101 in a wireless electromagnetic
1627 communications network for emergency services.
- 1628
- 1629 146. (original) The use of a method as in claim 1 in a wireless electromagnetic
1630 communications network for shared emergency communications without interference.
- 1631
- 1632 147. (currently amended) The use of an apparatus as in claim 50 101 in a wireless
1633 electromagnetic communications network for shared emergency communications without
1634 interference.
- 1635
- 1636 148. (original) The use of a method as in claim 1 in a wireless electromagnetic
1637 communications network for positioning operations without interference.
- 1638
- 1639 149. (currently amended) The use of an apparatus as in claim 50 101 in a wireless
1640 electromagnetic communications network for positioning operations without interference.
- 1641
- 1642 150. (original) The use of a method as in claim 1 in a wireless electromagnetic
1643 communications network for high reliabilty networks requiring graceful degradation
1644 despite environmental conditions or changes..
- 1645
- 1646 151. (currently amended) The use of an apparatus as in claim 50 101 in a wireless
1647 electromagnetic communications network for high reliabilty networks requiring graceful
1648 degradation despite environmental conditions or changes..
- 1649
- 1650 152. (original) The use of a method as in claim 1 in a wireless electromagnetic
1651 communications network for a secure network requiring assurance against unauthorized
1652 intrusion.
- 1653

- 1654 153. (original) The use of a method as in claim 1 in a wireless electromagnetic
1655 communications network for a secure network requiring message end-point assurance.
- 1656
- 1657 154. (original) The use of a method as in claim 1 in a wireless electromagnetic
1658 communications network for a secure network requiring assurance against unauthorized
1659 intrusion and message end-point assurance.
- 1660
- 1661 155. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wireless
1662 electromagnetic communications network for a secure network requiring assurance
1663 against unauthorized intrusion.
- 1664
- 1665 156. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wireless
1666 electromagnetic communications network for a secure network requiring message end-
1667 point assurance.
- 1668
- 1669 157. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a wireless
1670 electromagnetic communications network for a secure network requiring assurance
1671 against unauthorized intrusion and message end-point assurance.
- 1672
- 1673
- 1674 158. (original) The use of a method as in claim 1 in a cellular mobile radio service.
- 1675
- 1676 159. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a cellular
1677 mobile radio service.
- 1678
- 1679 160. (original) The use of a method as in claim 1 in a personal communication service.
- 1680
- 1681 161. (currently amended) The use of an apparatus as in claim ~~50~~ 101 in a personal
1682 communication service.
- 1683
- 1684 162. (original) The use of a method as in claim 1 in a private mobile radio service.

- 1685
- 1686 163. (currently amended) The use of an apparatus as in claim 50 101 in a private
1687 mobile radio service.
- 1688
- 1689 164. (original) The use of a method as in claim 1 in a wireless LAN.
- 1690
- 1691 165. (currently amended) The use of an apparatus as in claim 50 101 in a wireless LAN.
- 1692
- 1693 166. (original) The use of a method as in claim 1 in a fixed wireless access service.
- 1694
- 1695 167. (currently amended) The use of an apparatus as in claim 50 101 in a fixed wireless
1696 access service.
- 1697
- 1698 168. (original) The use of a method as in claim 1 in a broadband wireless access service.
- 1699
- 1700 169. (currently amended) The use of an apparatus as in claim 50 101 in a broadband
1701 wireless access service.
- 1702
- 1703 170. (original) The use of a method as in claim 1 in a municipal area network.
- 1704
- 1705 171. (currently amended) The use of an apparatus as in claim 50 101 in a municipal area
1706 network.
- 1707
- 1708 172. (original) The use of a method as in claim 1 in a wide area network.
- 1709
- 1710 173. (currently amended) The use of an apparatus as in claim 50 101 in a wide area
1711 network.
- 1712
- 1713 174. (original) The use of a method as in claim 1 in wireless backhaul.
- 1714

1715 175. (currently amended) The use of an apparatus as in claim 50 101 in wireless
1716 backhaul.

1717

1718 176. (original) The use of a method as in claim 1 in wireless backhaul.

1719

1720 177. (currently amended) The use of an apparatus as in claim 50 101 in wireless
1721 backhaul.

1722

1723 178. (original) The use of a method as in claim 1 in wireless SONET.

1724

1725 179. (currently amended) The use of an apparatus as in claim 50 101 in wireless SONET.

1726

1727 180-181. (Cancelled)

1728

1729 182. (original) The use of a method as in claim 1 in wireless Telematics.

1730

1731 183. (currently amended) The use of an apparatus as in claim 50 101 in wireless
1732 Telematics.

1733